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Girondi

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(54) **FILTERING UNIT**

(75) Inventor: **Giorgio Girondi**, Mantova (IT)

(73) Assignee: **UFI INNOVATION CENTER S.R.L.**, Ala (TN) (IT)

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B01D 46/00	(2006.01)
B01D 46/24	(2006.01)
B01D 53/22	(2006.01)
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B01D 65/08	(2006.01)

(52) **U.S. Cl.**

CPC ***B01D 50/002*** (2013.01); ***B01D 45/16*** (2013.01); ***B01D 46/0045*** (2013.01); ***B01D 46/2407*** (2013.01); ***B01D 46/2411*** (2013.01); *B01D 53/22* (2013.01); *B01D 63/14* (2013.01); *B01D 65/08* (2013.01); *B01D 2313/04* (2013.01); *B01D 2313/08* (2013.01); *B01D 2315/08* (2013.01); *B01D 2319/04* (2013.01); *B01D 2321/2016* (2013.01)

(58) **Field of Classification Search**

CPC .. B01D 46/2411; B01D 50/002; B01D 63/06; B01D 2313/02; B01D 2313/08; B01D 46/2407; B01D 45/16; B01D 46/0045; B01D 2319/04; B01D 2313/04; B01D 53/22; B01D 2315/08; B01D 63/14; B01D 65/08

USPC 55/337, 456, 457, 449, 498; 95/270; 210/304, 321.6, 321.87

See application file for complete search history.

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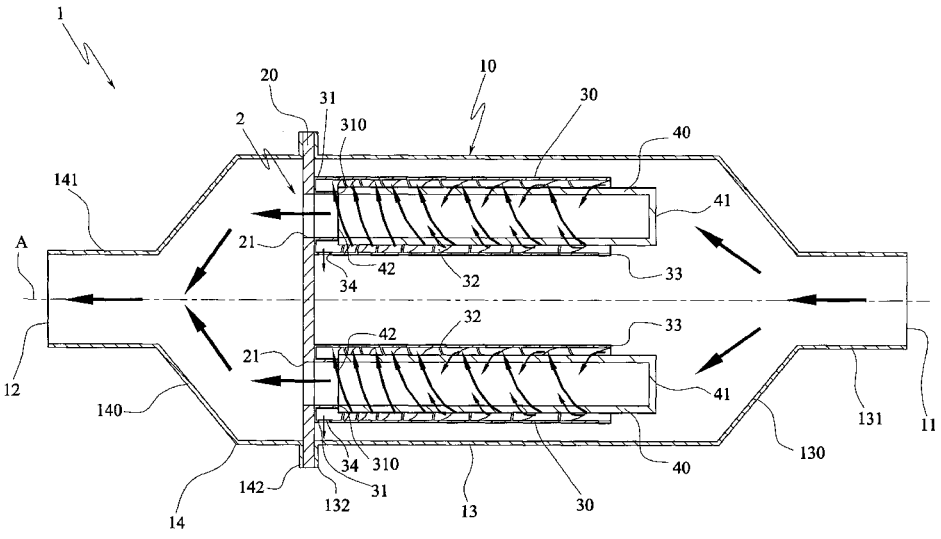
Primary Examiner — Dung H Bui

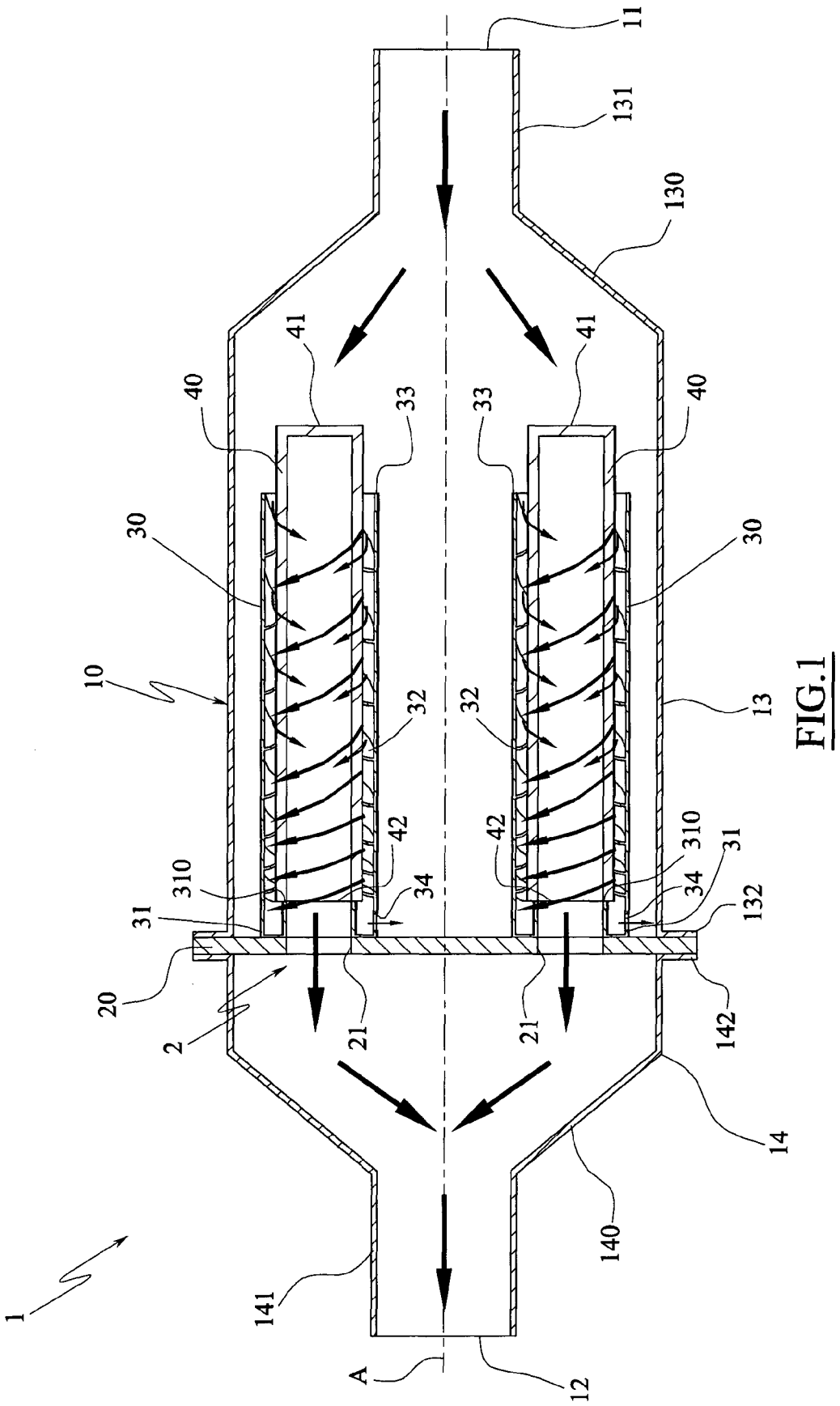
(74) *Attorney, Agent, or Firm* — Volpe and Koenig, P.C.

(57) **ABSTRACT**

A filtering cartridge (**2**), intended to be contained within an outer casing (TO) provided with an inlet (**11**) and an outlet (**12**) so as to filter the fluid which flows from the inlet (**11**) towards the outlet (**12**), the filtering cartridge (**2**) comprising at least one filtering membrane (**40**), characterized in that it comprises at least one tubular body (**30**) into which said filtering membrane (**40**) is fitted so as to be at least partly wound, the tubular body (**30**) comprising at least one fin (**32**) having helical development deriving from the internal wall of the tubular body (**30**).

8 Claims, 3 Drawing Sheets




11
131
130
41
40
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30
10
32
42
310
31
34
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2
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132
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140
141
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A
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13

FIG.1

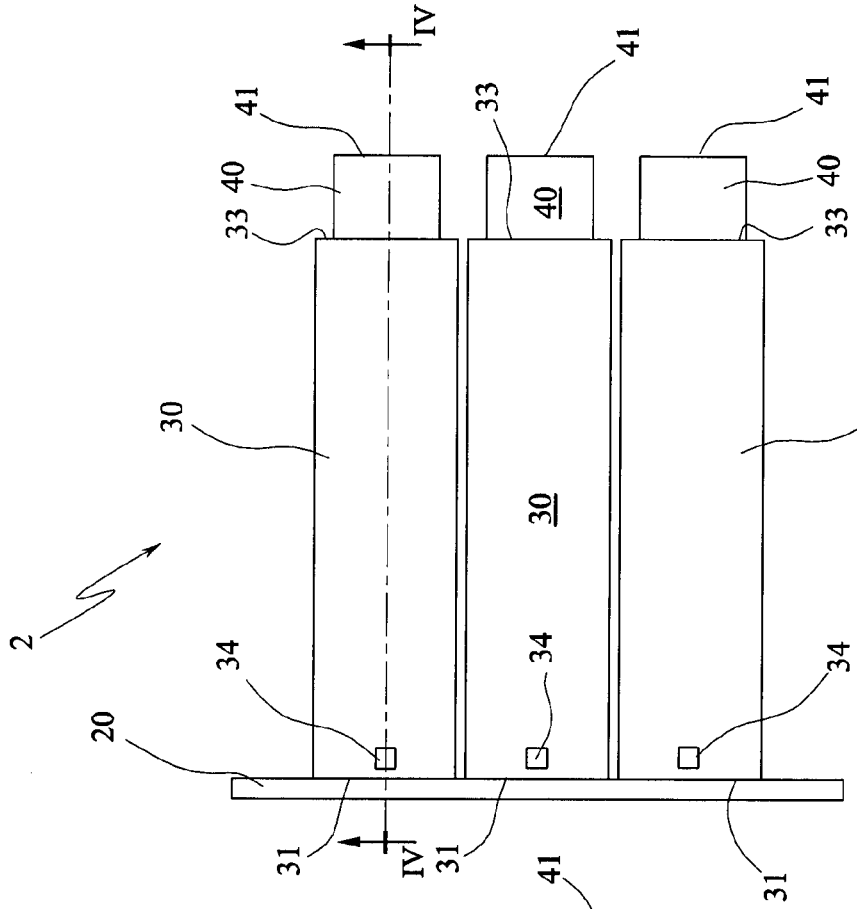

FIG.3

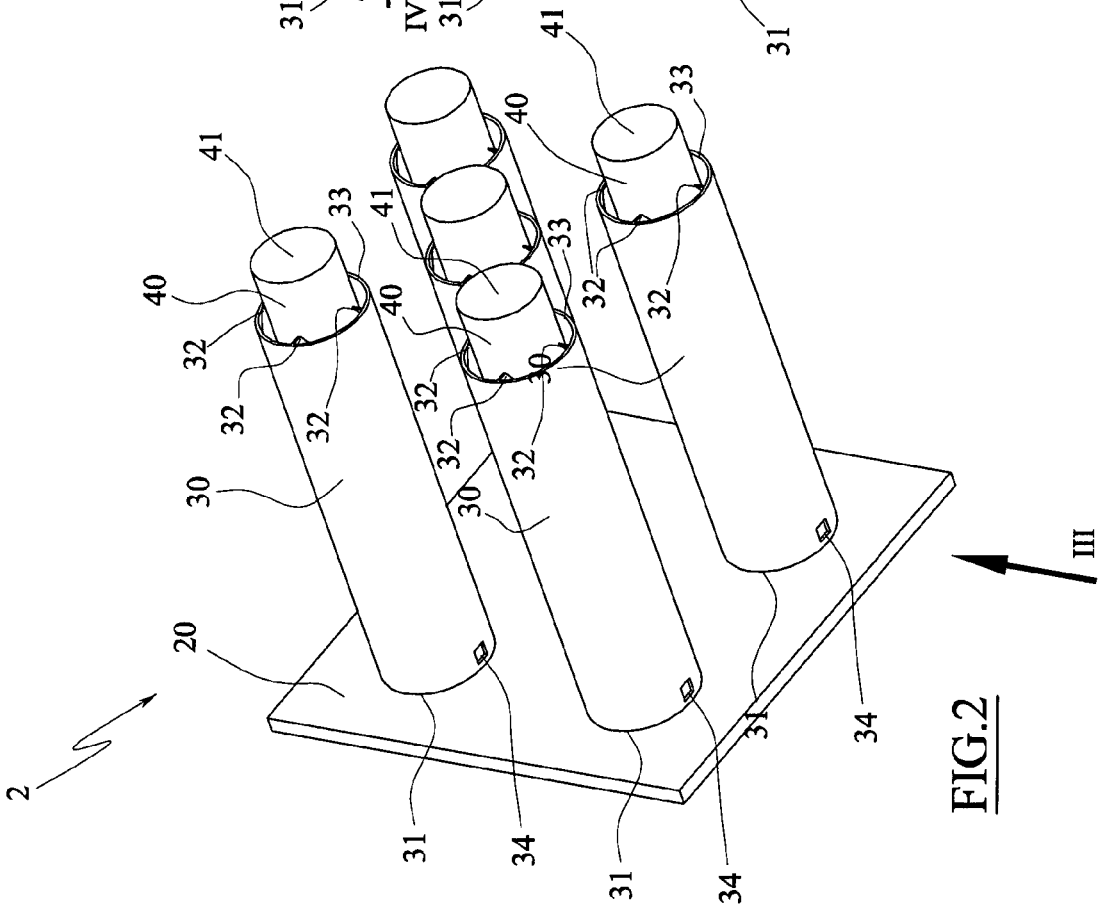

FIG.2

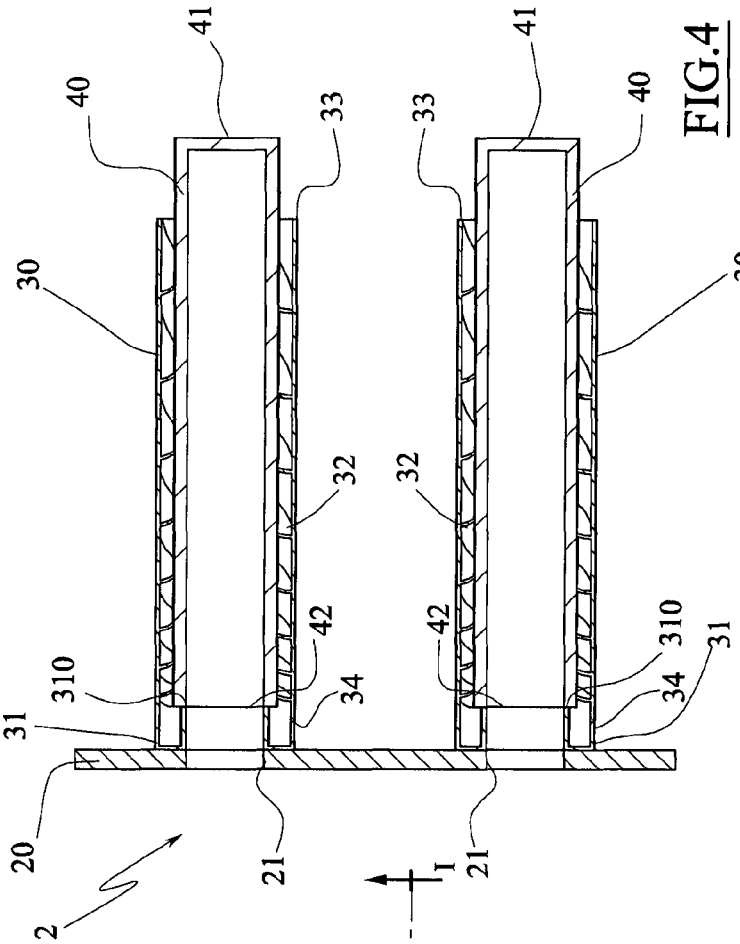

FIG.4

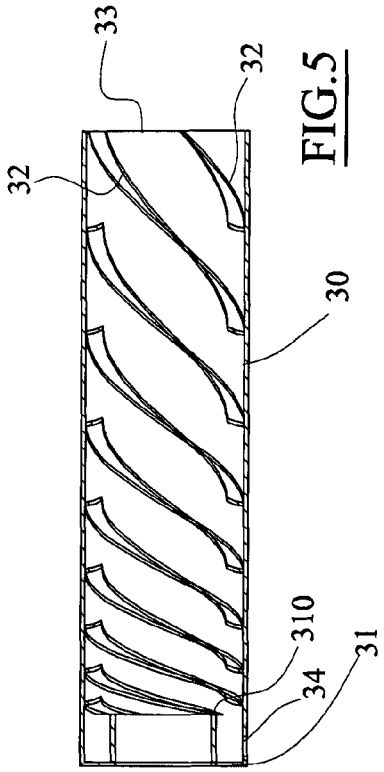

FIG.5

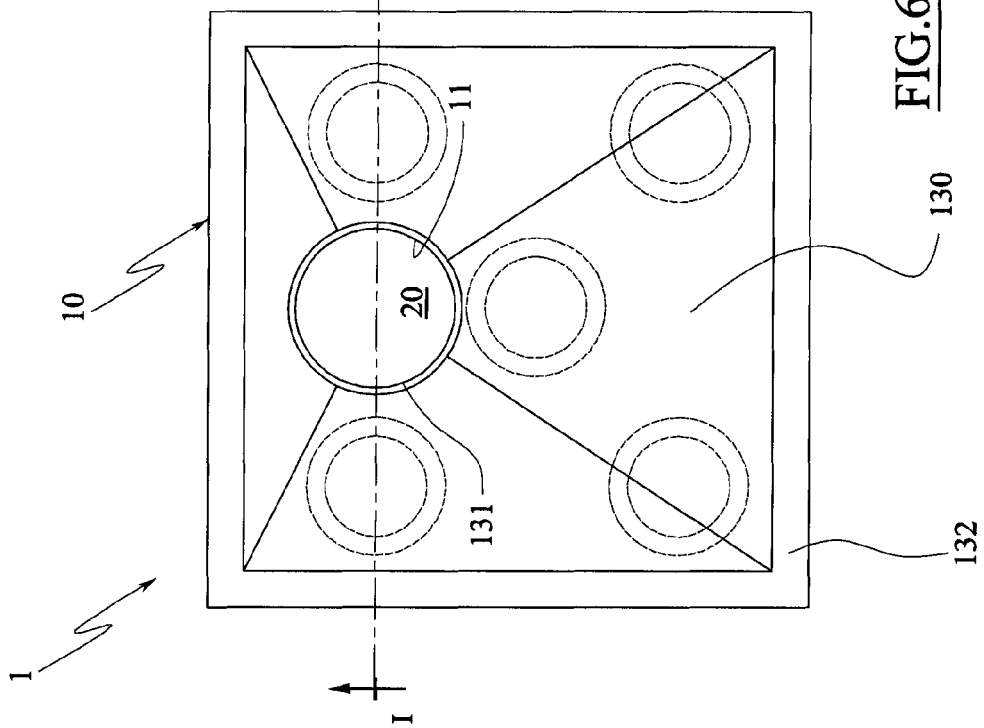

FIG.6

FILTERING UNIT

FIELD OF THE INVENTION

The present invention generally regards filtering fluids, especially filtering motor-vehicle fluids, particularly including filtering the air which is intaken by an internal combustion engine.

PRIOR ART

As known, air (or generally gases), which is intaken by an internal combustion engine is commonly subjected to a filtering step aimed at purifying it from the solid particles in suspension, typically powders of various types, so that the latter do not reach the engine combustion chamber. This filtering stage is typically executed through a special filtering unit, which is located along the intake conduit of the internal combustion engine, upstream of the intake manifold and the turbocharger if present.

The filtering unit schematically comprises an outer casing, usually called filtering box, which is provided with an inlet for the air to be filtered and an outlet of the filtered air, and a filtering cartridge housed within said filtering box for filtering the air which flows from the inlet towards the outlet. The filtering cartridge comprises at least one filtering material element, for example based on cellulose or polymer material, and at least one support plate for said filtering material element. The support plate is coupled to the filtering box so that the filtering material element is adapted to divide the internal volume thereof in two separate chambers, including a first chamber communicating with the inlet and a second chamber communicating with the outlet. Thus, the air which flows from the inlet towards the outlet of the filtering box is forced to traverse the filtering material element, which withholds the solid particles in suspension. Given that said solid particles progressively obstruct the filtering material element, it is commonly provided for that the filtering cartridge can be removed from the filtering box, so as to replace it when the filtering material element is excessively clogged.

One of the main needs related to this type of filtering units consists in providing filtering cartridges which maintains a high filtering capacity over time, i.e. capable of guaranteeing a high useful life and thus such to reduce the interventions for replacement thereof.

Filtering units having filtering membranes to which there are combined centrifuge systems for separating the most coarse solid particles, which are arranged in the first chamber which is communication with the inlet of the filtering unit were proposed with the aim of meeting this need.

The American U.S. Pat. No. 4,303,423 for example discloses an air filter whose outer casing defines an internal environment, within which there is inserted a substantially toroidal filtering membrane positioned so as to divide such environment in a first chamber communicating with the inlet for the air to be filtered and a second chamber in connection with the outlet of the filtered air. On the upper wall of the casing there are made holes, provided with deflector fins, such holes defining the inlet of the aria. The fins are, in particular, adapted to impart a helical motion to the air within the casing.

Furthermore, the internal wall of the casing has one or more propellers which extend over the entire longitudinal extension of the casing so as to accentuate the windmill motion imparted to the air within the first chamber of the casing.

The windmill motion imparted by the fins and by the propeller, allows pre-separating—from the air which enters into the first chamber—the heaviest fraction of solid impurities before traversing the filtering membrane, preventing such particles from clogging the filtering membrane prematurely. Then, in proximity of the bottom of the casing there is provided a hole with a fan for discharging the solid impurities which are separated in the chamber upstream of the filtering membrane due to the centrifuge action imparted to the air.

Though increasing the life of the filtering cartridge, this technical solution reveals the drawback lying in the fact that, if used with high air flow rates, it would require a considerable increase of the dimensions of the filtering membrane (outer diameter, inner diameter, height) and the dimensions of the first chamber and the height of the propeller, so as to house large amounts of solid impurities that accumulate at the propeller; all this would lead to a high overall dimension of the filtering unit and a low pre-separation efficiency of the solid fraction of the impurities present in the air to be subjected to filtering.

Furthermore, a further drawback regarding the filtering units with centrifuge pre-filtration action of the known type lies in the fact that the shape and dimensions of the casing are bound to the desired centrifuge effect, hence the outer casing will always be substantially cylindrical-shaped and, should there arise the need for filtering large air flow rates, it will have considerable overall dimensions.

Thus, this implies that such type of filtering units are hardly used in automotive industry applications in which the casing of the filtering unit must, due to needs regarding overall dimensions within the engine compartment of the vehicle, have complex configurations or are required to be small in size.

An object of the present invention is to overcome the aforementioned drawbacks of the prior art, through a simple, rational and inexpensive solution.

These objects are attained by the characteristics of the invention indicated in the independent claim. The dependent claims outline preferred and/or particularly advantageous aspects of the invention.

DESCRIPTION OF THE INVENTION

In particular, the invention provides a filtering cartridge, intended to be contained within an outer casing provided with an inlet and an outlet so as to filter the fluid which flows from the inlet towards the external, the filtering cartridge comprising at least one filtering membrane, characterised in that it comprises at least one tubular body into which said filtering membrane is fitted so as to be at least partly wound, the tubular body comprising at least one fin having helical development deriving from the internal wall of the tubular body.

Due to this solution, the filtering capacity of the filtering cartridge is independent from the dimensions and from the shape the casing of the filtering unit into which it is inserted.

Furthermore, an aspect of the present invention provides for that the fin be provided with a height substantially equivalent to the difference between the inner diameter of the tubular body and the outer diameter of the filtering membrane.

Thus, the height of the fins can be dimensioned so as to optimise the collection of solid particulate, as a function of the air flow rate traversing the filtering cartridge.

An aspect of the invention provides for that the fin be provided with a variable pitch along the longitudinal axis of the tubular body.

This solution allows optimising the path and the speed of the air before it traverses the filtering membrane, so as to improve the separation of the coarse solid part from the air to be subjected to filtration.

Still another aspect of the invention provides for that the filtering membrane be provided with a closed end and an open opposite end.

Advantageously, the tubular body comprises at least one annular abutment adapted to be fixed to the open end of the filtering membrane so as to divide the environment within the filtering membrane from the external environment thereby.

This solution allows providing an obligatory passage for the air which guarantees an efficient centrifuge separation of the coarse solid particulate and an efficient filtration through the filtering membrane.

A further aspect of the invention provides for that the tubular element comprises at least one discharge gap on the lateral wall thereof.

This solution allows discharging, outside the tubular body, the separated solid particulate due to the centrifuge action from the fin of the tubular body.

Furthermore, an aspect of the present invention provides for that the filtering cartridge comprises a plurality of filtering membranes and a plurality of respective tubular bodies, each of which is associated to the support element at a respective hole made therein.

Due to this solution, the filtering cartridge, comprising several filtering membranes which are arranged so as to be traversed parallel by the air which flows, considering the use of the same filtering material, considerably increases the filtering surface through which the air can pass, and thus the filtering surface on which the solid particles in suspension may accumulate, thus further increasing the life of the filtering cartridge specie.

Furthermore, the overall dimension of the filtering cartridge may however be limited, regardless the use of high airflows to be subjected to filtering.

A further aspect of the invention provides a filtering unit comprising an outer casing provided with at least one inlet and an outlet and a filtering cartridge, as described above, contained within the casing, so as to filter the fluid which flows from the inlet towards the outlet.

The filtering membrane is adapted to divide the internal volume of the casing in a first volume communicating with the inlet and a second volume communicating with the outlet.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages of the invention will be apparent from reading the following description provided by way of non-limiting example, with reference to the figures illustrated in the attached figures.

FIG. **1** is the section I-I of FIG. **6**, regarding a filtering unit according to an embodiment of the present invention.

FIG. **2** is an axonometric view of a filtering cartridge according to an embodiment of the present invention.

FIG. **3** is a lateral view from III of FIG. **2**.

FIG. **4** is the section IV-IV of FIG. **3**.

FIG. **5** is the FIG. **4** without the filtering membrane.

FIG. **6** is a lateral view of the filtering unit of FIG. **1**.

PREFERRED EMBODIMENT OF THE INVENTION

FIG. **1** shows a filtering unit **1**, which is adapted to purify an airflow from the solid particles possibly present in suspension. More in particular, the filtering unit **1** is intended to be positioned along an intake conduit of un internal combustion engine, so as to filter the comburent air that is supplied within the combustion chambers of the engine.

The filtering unit **1** comprises an outer casing **10**, conventionally referred to as filtering box, which can be provided globally made of plastic material. The outer casing **10** delimits an internal volume and it is provided with an inlet **11** for the air to be filtered and an outlet **12** for the filtered air, both communicating with said internal volume. The inlet **11** is intended to remain in communication with the external environment, while the outlet **12** is adapted to remain in communication with the engine combustion chambers, usually through an intake manifold.

The outer casing **10** is globally polyhedron-shaped, an extended polyhedron with longitudinal axis A in this case.

In this case, the outer casing **10** comprises a first body **13** substantially drinking-glass-shaped on whose bottom **130** (to the right in FIG. **1**) there is provided a conduit **131** with central axis substantially parallel to the longitudinal axis A and defining the inlet **11**.

The top part of the first body **13** comprises an edge **132** folded defining a surface substantially orthogonal to the lateral walls of the first body.

Furthermore, the outer casing **10**, comprises a second body **14** also substantially drinking-glass-like on whose bottom **140** (on the left in FIG. **1**) there is provided a conduit **141** with central axis substantially parallel to the longitudinal axis A and defining the outlet **12**.

The top part of the second body **14** comprises an edge **142** folded defining a surface substantially orthogonal to the lateral walls of the first body.

The edge **142** of the second body **14** is adapted to face the edge **132** of the first body **13** for the substantially hermetic closure of the outer casing **10**.

The outer casing **10** has a substantially quadrangular transverse section (square-shaped in the example), but it cannot be excluded that the section can be shaped differently, same case applying to the arrangement of the conduits **132** and **142** in the respective bodies which can be shaped differently depending on the construction needs.

The filtering unit **1** comprises a filtering cartridge, indicated in its entirety with **2**, adapted to be mounted within the casing **10**.

As illustrated in FIGS. **2-4**, the filtering cartridge **2** comprises a substantially flat support flange **20** provided with a plurality of through openings **21**, **5** in this case arranged to form a quincunx.

The filtering cartridge **2** further comprises a plurality of substantially cylindrical tubular bodies **30**.

A first end **31** of each of the tubular bodies **30** is associated to the support flange **20** at each of the through openings and coaxially with respect thereto. The support flange **20**, with shape conjugated to the section—in plan view—of the outer casing **10**, is adapted to be clamp-retained between the edge **132** of the first body **13** and the edge **142** of the second body **14**, for example by interposing suitable sealing gaskets, so that the tubular bodies **30** are contained within the first body **13** i.e. facing towards the inlet **11**.

In the embodiment shown in the figures, each tubular body **30** is fixed integrally to the support plate **20** for example through gluing or any other equivalent means, but it cannot be excluded that the tubular body **30** be removably associated to the support plate **2**, for example through snap-coupling or bayonet-coupling means, known to a man skilled in the art.

At the first end **31** of each tubular body **30** there is an annular abutment **310** having an inner diameter smaller than the diameter of the tubular body and substantially equivalent to the diameter of the through openings **21**, whose outer surface is intended to rest against the support flange **20**, sub-

stantially contouring a through opening **21**, for the substantially sealing connection between the tubular body **30** and the support flange.

In the preferred embodiment shown in the figures, each tubular body **30** comprises at least one fin **32** having helical development, which is extended over the entire longitudinal development of the tubular body **30**, from the first end **31** and a second end **33** thereof, and it is derived from the internal wall thereof.

However, it is not excluded that the fin **32** extends over a limited portion of the longitudinal development of the tubular body **30**, for example a portion proximal to the second end **33** thereof. The length of the portion in which the fin **32** develops is, for example, dimensioned depending on the flow rate in question in the filtering unit **1**, on the sections for the passage of air available and on the desired performance (pressure drop caused by the fin **32**, accumulation of solid particles removed from the air by the fin, etc. . . .).

The fin **32** has a height (distance from the crest thereof to the internal wall of the tubular body **30**) which at most is equivalent to the difference between the internal diameter of the tubular body and the diameter of the through opening **21**.

Furthermore, the fin **32** has a variable pitch along the longitudinal axis of the tubular body **30**, for example, it has a pitch continuously decreasing from the second end **33** towards the first end **31**.

Furthermore, it cannot be excluded that the tubular body **30** be provided with a helical fin **32** (the illustrated example has **4** fins **32** that start from points angularly spaced from each other by 90° as observable in FIG. **2**).

Furthermore, each tubular body **30** comprises at least one discharge gap **34** provided on the lateral wall of the tubular body **30** which is obtained at the first end **31**.

The filtering cartridge **2** further comprises a plurality of filtering membranes **40**, five in the example, tubular shaped, each of which has a closed end **41**, for example through a closure plate or by pressing the same, and an open opposite end **42** which is adapted to face the support flange **2** at one of the openings **21**.

In practice, each filtering membrane **40** is adapted to be coaxially fitted within a tubular body **30**, so that the open end **42** thereof is moved to contact with inner face of the annular abutment **310**.

In practice, each filtering membrane **40** is perfectly fitted within tubular body **30**, so that the fins **32** touch the outer lateral surface of the filtering membrane.

In a first embodiment, shown in the figures, each filtering membrane **40** is fixed, for example by gluing the open end **42**, to the abutment element **32**.

In a second alternative embodiment, each filtering membrane **40** comprises, at the open end **42** an annular plate provided with sealing coupling means, known in the sector, adapted to be decoupled at corresponding coupling means made at the annular abutment **310**.

In the preferred embodiment shown in the figures each tubular body **30** has a longitudinal development substantially smaller with respect to the longitudinal development of each filtering membrane **40**, the closed end **41** of the filtering membrane **40** thus projects externally with respect to the tubular body.

However, it is not excluded that the tubular body **30** can have a length greater or equivalent to the length of the respective filtering membrane **40** and that the tubular bodies **30**, as well as the filtering membranes **40** of the filtering cartridge **2**, may have different lengths and or dimension with respect to each other.

Preferably, each filtering membrane **40** is obtained from non-woven fabric material made of mutually intertwined fibres, which can be provided through the melt blown process and using the polymeric type of fibre, for example made of polypropylene; the filtering membrane **40** can alternatively be of the pleated membrane type made of a non-woven fabric with fibres made of cellulose and/or polymeric material and/or fiberglass.

In the light of the description outlined above, the filtering unit **10** operates as follows.

All the air that flows from the inlet **11** towards the outlet **12** of the casing **10**, is forced to axially enter into the interspace defined between each filtering membrane **40** and the respective tubular body **30** where, due to the fin **31**, there is conferred a windmill-like rotary motion.

Due to the centrifuge force, the solid particles suspended in the air are separated from the air and they are collected by the fin **31** and carried towards the discharge gap **34**, from which they drop for example due to gravity on the lower wall of the first body **13**.

The air from which the most coarse solid particles were pre-separated is thus forced to pass through the filtering membrane **40** (traversing it from the external towards the internal), which completes the filtration thereof up to the desired degree and, through the through opening **21**, it passes from the first body **13** to the second body **14** and, lastly, exits from the outer casing **10** through the outlet **12**.

The invention thus conceived can be subjected to numerous modifications and variants all falling within the inventive concept.

Furthermore, all details can be replaced by other technically equivalent elements.

In practice, the materials used as well as the shake and contingent dimensions, may vary depending from the needs without departing from the scope of protection of the following claims.

The invention claimed is:

1. Filtering unit (**1**), comprising an outer casing (**10**) provided with at least one inlet (**11**) and an outlet (**12**) and a filtering cartridge (**2**) contained within the outer casing (**10**) so as to filter a fluid which flows from the at least one inlet (**11**) towards the outlet (**12**), the filtering cartridge (**2**) comprising at least one tubular-shaped filtering membrane (**40**), having a closed end (**41**) and an open opposite end (**42**) and at least one tubular body (**30**) into which said at least one filtering membrane (**40**) is fitted so as to be at least partly wound, the at least one tubular body (**30**) comprising:

at least one fin (**32**) having helical development deriving from an internal wall of the at least one tubular body (**30**); and

at least one discharge gap (**34**) on the lateral wall thereof.

2. The filtering unit (**1**) according to claim **1**, wherein the at least one fin (**32**) has a height substantially equivalent to a difference between an inner diameter of the at least one tubular body (**30**) and an outer diameter of the at least one filtering membrane (**40**).

3. The filtering unit (**1**) according to claim **1**, wherein the at least one fin (**32**) has a variable pitch along a longitudinal axis of the at least one tubular body (**30**).

4. The filtering unit (**1**) according to claim **1**, wherein the at least one tubular body (**30**) comprises at least one annular abutment (**310**) adapted to be fixed to the open end (**42**) of the at least one filtering membrane (**40**) so as to divide the environment within the at least one filtering membrane (**40**) from an external environment thereby.

5. The filtering unit (1) according to claim 4, wherein the at least one annular abutment (310) is provided at an end (31) of the at least one tubular body (30).

6. The filtering unit (1) according to claim 1, further comprising a support element (20) provided with at least one through opening (21) to which the at least one tubular body (30) is coaxially associated.

7. The filtering unit (1) according to claim 6, wherein the at least one tubular body (30) is integrally fixed to the support element (20).

8. The filtering unit (1) according to claim 6, wherein the at least one tubular body (30) is removably associated to the support element (20) through a coupling member.

* * * * *